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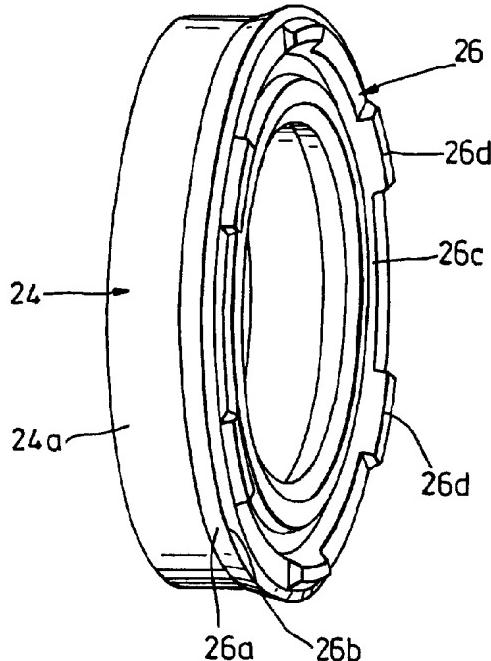
(71) Applicant: **Automotive Products (USA) Inc.  
Detroit, Michigan 48326-1754 (US)**

(72) Inventors:  
• **Peterson, David C.  
Walled Lake, Michigan 48088 (US)**  
• **Iyer, Rajiv  
Rochester, Michigan 48307 (US)**

(74) Representative: **Morrall, Roger  
Automotive Products plc  
Patent Department  
Tachbrook Road  
Leamington Spa, Warwickshire, CV31 3ER (GB)**

### (54) Seal assembly for annular hydraulic cylinder

(57) A seal assembly especially suitable for use as the sealing element in an annular cylindrical bore (18) of a concentric cylinder assembly. The seal assembly includes an annular insert structure (24) of rigid material and an annular seal member (26) of elastomeric material bonded to the insert structure. The annular insert structure has an I-beam cross-sectional configuration including an outer annular flange structure (24a) centered on an axis, an inner annular flange structure (24b) centered on the axis concentrically within the outer annular flange structure, and annular web structure (24c) extending radially between the inner and outer annular flange structures. The web structure coacts with the flange structures to define left and right continuous annular grooves (30,32) in the left and right faces (24d, 24a) of the insert structure and defines a plurality of circumferentially spaced holes (24j) extending axially through the web structure between the left and right grooves. The annular elastomeric seal member (26) fills the left and right grooves, fills the web structure holes, and extends to one side of the insert structure to form inner and outer annular sealing surfaces (26b,26a) for coaction with the respective annular surfaces of the annular cylindrical bore.



**Fig. 2**

**Description**Field of the Invention

**[0001]** This invention relates to a seal assembly and more particularly to a seal assembly especially suitable for use as the seal element in an annular hydraulic cylinder and piston assembly such, for example, as a concentric sleeve cylinder assembly for operating the throw-out bearing of a vehicular clutch.

**[0002]** In a concentric slave cylinder an annular piston is slidably positioned in an annular cylindrical bore and an annular seal element is positioned in the annular bore and acts in association with the piston to define a hydraulic fluid pressure chamber on the power side of the piston. Whereas various annular seal designs have been proposed for use in concentric slave cylinders, each of the prior art designs has suffered from one or more disadvantages. Specifically, the prior art seals have had an excessively complicated and expensive construction; and/or the prior art seals have provided only a relatively short product life; and/or the prior art seals have had a tendency to cock in the cylindrical bore so as to complicate their insertion in the bore and derange the sealing performance of the seal in the bore; and/or the prior art seals have generated excessive friction and squirming as between the seal and the bore; and/or the prior art seals have exhibited an excessive system hysteresis effect.

Summary of the Invention

**[0003]** It is an object of the present invention to provide a seal assembly which is especially suitable for use in a concentric slave cylinder and which is of a simple, inexpensive, durable and efficient construction.

**[0004]** Thus according to the present invention there is provided a seal assembly comprising:

an annular insert structure of rigid material centered on an axis and having an annular outer structure, an annular inner structure, left and right annular radial faces, and a continuous annular groove in said right radial face; and

an annular seal member of elastomeric material bonded to the insert structure, filling said groove, and extending to the right of the insert structure to form a seal structure defining an outer annular sealing surface having a relaxed configuration positioned radially outwardly and to the right of the annular outer insert structure and an inner annular sealing surface having a relaxed configuration radially inwardly and to the right of the annular inner insert structure.

**[0005]** This basic seal design provides a simple and inexpensive construction; minimizes cocking of the seal assembly in the bore; minimizes friction as between the

seal and the bore; and reduces the system hysteresis effect.

**[0006]** Preferably the insert structure further defines a plurality of circumferentially spaced holes extending axially through the insert structure from the groove to the left annular radial face and the elastomeric material fills the holes. This specific arrangement ensures a positive bonding of the elastomeric material to the rigid material of the insert structure.

**[0007]** The insert structure preferably further defines a continuous annular groove in the left annular radial face of the inside structure; the holes extend between the left and right grooves; and the elastomeric material fills the left groove. This specific interrelationship between the elastomeric material and the structure of the insert further enhances the bond between the elastomeric material and the insert.

**[0008]** The insert structure has preferably an I-beam cross-sectional configuration including an outer annular flange structure forming the annular outer structure, an inner annular flange structure forming the annular inner structure, and an annular web structure extending radially between the inner and outer flange structures and having a left face coacting with left portions of the inner and outer annular flange structures to form the left groove and coacting with right portions of the inner and outer annular flange structure to form the right groove; and the holes extend through the web structure and connect with the left and right grooves. This specific I-beam construction for the insert structure provides strength to the assembly and facilitates the bonding of the elastomeric material to the insert structure.

**[0009]** The seal structure is preferably free to flex in a sealing scenario to allow the inner annular sealing surface to assume a working position in approximate alignment with the radially inner annular surface of the inner flange structure and allow the outer annular sealing surface to assume a working position in approximate alignment with the radially outer annular surface of the outer flange structure. To facilitate such flexing the seal structure preferably defines an annular groove between the inner and outer sealing surfaces.

Brief Description of the Drawings

**[0010]**

FIG. 1 is a fragmentary and diagrammatic view of a concentric piston and cylinder assembly employing a seal assembly according to the invention;  
**50** FIGS. 2 and 3 are perspective views of the seal assembly;  
**55** FIG. 4 is a fragmentary view of the seal assembly;  
FIG. 5 is a fragmentary view of an insert structure employed in the seal assembly;  
FIG. 6 is a diagrammatic view showing the formation of the seal assembly; and  
FIG. 7 is a fragmentary view taken within the circle

7 of Fig. 1.

#### Detailed Description of the Preferred Embodiment

**[0011]** The invention seal assembly 10 is seen in FIG. 1 in use in an angular hydraulic cylinder and piston assembly, such for example as a slave cylinder assembly for operating the throw-out bearing of a vehicular clutch wherein the cylinder and piston assembly is disposed concentrically around the drive shaft connecting the clutch to the gear box of the vehicle.

**[0012]** The slave cylinder assembly includes a housing 12 provided with concentric tubular members 14 and 16 preferably cast integrally with housing 12. Members 14 and 16 coaxially define an annular cylindrical chamber 18, and an annular piston 20 is slidably positioned in chamber 18. Seal assembly 10 is disposed in chamber 18 on one side of annular piston 20 so that hydraulic fluid introduced into the annular chamber 18 through a passageway 22 in housing 12 displaces the seal assembly 10 and piston 20 to the left as seen in FIG. 1, thereby displacing to the left a throw-out bearing engaged by the free end of the annular piston. The throw-out bearing in turn engages the release fingers of the clutch of the vehicle in known manner to disengage the clutch. When hydraulic fluid is withdrawn from chamber 18, piston 20 is allowed to be displaced to the right under the action of the clutch spring fingers and the clutch is reengaged in known manner. A sleeve cylinder assembly of the type shown in FIG. 1 is disclosed for example in U.S. Patent No. 4,577,549.

**[0013]** Seal assembly 10 includes an annular insert member 24 and an annular elastomeric member 26.

**[0014]** Annular insert member 24 (FIG. 5) is formed in a suitable injection molding process of a suitable plastic material such as a glass reinforced plastics or a mineral filled plastics. Insert member 24 is in the form of a ring member and has an I-beam cross-sectional configuration including an outer annular flange structure 24a centered on an axis 28, an inner annular flange structure 24b centered on the axis concentrically within the outer annular flange structure, and an annular web structure 24c extending radially between the inner and outer annular flange structures. Web structure 24c has a left annular radial face 24d coaxial with left portions 24e, 24f of the inner and outer annular flange structures to define a left continuous annular groove 30 and has a right annular radial face 24g coaxial with right portions 24h and 24i of the inner and outer flange structures to define a right continuous annular groove 32. Web structure 24c further defines a plurality of circumferentially spaced circular holes 24j extending axially through the web structure between the left and right grooves. Holes 24j may have any desired diameter but preferably, and as shown, extend the full height of the web structure.

**[0015]** Following the injection molding of ring member 24, the ring member is coated with a suitable adhesive or bonding agent and placed in a suitable mold where,

in a known flashless molding process, elastomeric material is molded around the insert member. More specifically, and as seen in FIG. 6, ring member 24 is positioned in an annular mold cavity 34a defined by a mold part 34; a further mold part 36 is affixed to mold part 34 and defines a mold cavity 36a coaxial with mold cavity 34a to define the complete mold cavity; and elastomeric material in molten form is injected into the mold cavity through a sprue 38 defined by a sprue bushing 40 positioned in mold part 34. The molten elastomeric material flows through sprue 38 and into mold cavity 34a, 36a and specifically fills groove 30, fills holes 24j, fills groove 32, and fills mold cavity 36a to define a seal structure 26a. Once the elastomeric material has set up, mold parts 36 and 34 are separated and the seal assembly comprising ring member 24 and elastomeric member 26 molded thereto is removed from the mold.

**[0016]** In the final configuration of the seal assembly, elastomeric material fills the left groove 30; fills the circumferentially spaced holes 24j; fills the right groove 32; and extends to the right of the ring member 24 (as viewed in the drawings) to define the seal structure 26a. Seal structure 26a (FIGS. 2, 3 and 4) defines an outer annular lip sealing surface 26b having a relaxed configuration positioned radially outwardly and to the right of the annular outer insert structure 24a and an inner annular lip sealing surface 26b having a relaxed configuration radially inwardly and to the right of the annular inner insert structure 24b. Seal structure 26 further defines an annular groove 26c between the inner and outer lip sealing surfaces to facilitate flexing movement of the inner and outer sealing surfaces between their relaxed and their working positions. Seal structure 26 further desirably includes a plurality of circumferentially spaced spacer portions 26d.

**[0017]** In use in a concentric slave cylinder assembly, and as best seen in FIGS. 1 and 7, seal assembly 10 is received in annular bore 18 with insert member 24 maintaining a running clearance with the concentric walls defining the annular bore and with lip sealing surfaces 26a and 26b sealingly engaging the inner and outer annular surfaces of the bore to define a fluid pressure chamber in the right side of the bore acting to urge the seal assembly and the piston to the left to actuate the clutch in known manner. Spacers 26 operate to prevent movement of the seal structure to a position at the extreme right end of bore 18 where pressurized fluid entering passage 22 would have no access to the right face of the seal. The seal structure is shown in its relaxed configuration by the dash lines in FIG. 7 and is shown by the solid lines in FIG. 7 in its working position in sealing engagement with the inner and outer annular surfaces defining the annular bore.

**[0018]** The seal assembly of the invention will be seen to minimize the disadvantages of the prior art seal assemblies. Specifically, the invention seal assembly is simple and inexpensive in construction; the invention seal assembly is durable and provides a long product

life; the invention seal assembly, by virtue of the close running clearance between the rigid insert member and the walls of the bore, is precluded from cocking in the bore; the strength and rigidity provided by the insert member precludes excessive squirming of the elastomeric material as the seal assembly moves in the bore whereby to minimize friction in the seal assembly; and the invention seal assembly, by virtue of its smooth, low friction non-squirming movement in the cylinder bore, minimizes the system hysteresis effect.

[0019] Whereas a preferred embodiment of the invention has been illustrated and described in detail, it will be apparent that various changes may be made in the disclosed embodiment without departing from the scope or spirit of the invention.

## Claims

### 1. A seal assembly (10) comprising:-

an annular insert structure (24) of rigid material centered on an axis and having an annular outer structure (24a), an annular inner structure (24b), left and right annular radial faces (24d, 24g), and a continuous annular groove (32) in said right radial face; and an annular seal member (26) of elastomeric material bonded to the insert structure, filling said groove (32), and extending to the right of the insert structure to form a seal structure defining an outer annular sealing surface (26b) having a relaxed configuration positioned radially outwardly and to the right of the annular outer insert structure (24a) and an inner annular sealing surface (26b) having a relaxed configuration radially inwardly and to the right of the annular inner insert structure (24b).

### 2. A seal assembly according to claim 1 wherein:-

the insert structure (24) further defines a plurality of circumferentially spaced holes (24j) extending axially through the insert structure from the groove (32) to the left annular radial face (24d); and the elastomeric material (26) fills the holes.

### 3. A seal assembly according to claim 1 or 2 wherein:-

the insert structure (24) further defines a continuous annular groove (30) in the left annular radial face (24d) of the insert structure; the holes (24j) extend between the left (30) and right (32) grooves; and the elastomeric material (26) fills the left groove (30).

### 4. A seal assembly according to any one of claims 1 to 3 wherein:-

the insert structure (24) has an I-beam cross-sectional configuration including an outer annular flange structure (24a) forming the annular outer structure, and inner annular flange structure (24b) forming the annular inner structure, and an annular web structure (24c) extending radially between the inner and outer flange structures and having a left face (24d) coacting with left portions (24e,24f) of the inner and outer annular flange structures (24b,24a) to form the left groove (30) and coacting with right portions of the inner and outer annular flange structures (24b,24a) to form the right groove (32); and the holes (24j) extend through the web structure and connect the left and right grooves.

### 5. A seal assembly according to any one of claims 1 to 4 wherein the seal structure (26) is free to flex when in use to allow the inner annular sealing surface (26b) to assume a working position in approximate alignment with the radially inner annular surface of the inner flange structure (24b) and allow the outer annular sealing surface (26b) to assume a working position in approximate alignment with the radially outer annular surface of the outer flange structure (24a).

### 6. A seal assembly according to any one of claims 1 to 5 wherein:

the seal member (26) defines an annular groove (26c) between the inner and outer sealing surfaces to facilitate flexing movement of the inner and outer sealing surfaces to their working positions.

### 7. A seal assembly according to any one of claims 1 to 6 wherein:-

the seal member includes axially projecting spacer portions to prevent full face contact of the seal with an end of an associated bore.

### 8. A concentric cylinder assembly including a seal assembly according to any one of claims 1 to 7 to seal an annular piston within an annular bore.

### 9. A method of manufacturing a seal assembly comprising the steps of-

- molding an annular insert having an annular outer structure, an annular inner structure, left and right annular radial faces, and a continuous annular groove in said right radial face;

- coating the insert with an adhesive or bonding agent;
- placing the coated insert into a mold defining on or more cavities around the insert;
- injecting elastomeric material into said cavity or      5  
cavities to form an annular seal bonded to the insert, and
- removing the completed seal assembly from the mold.

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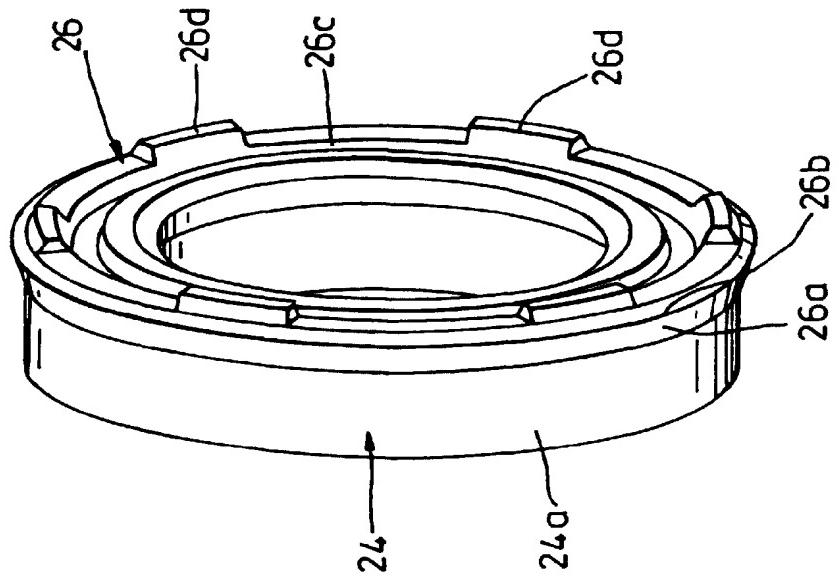


Fig. 2

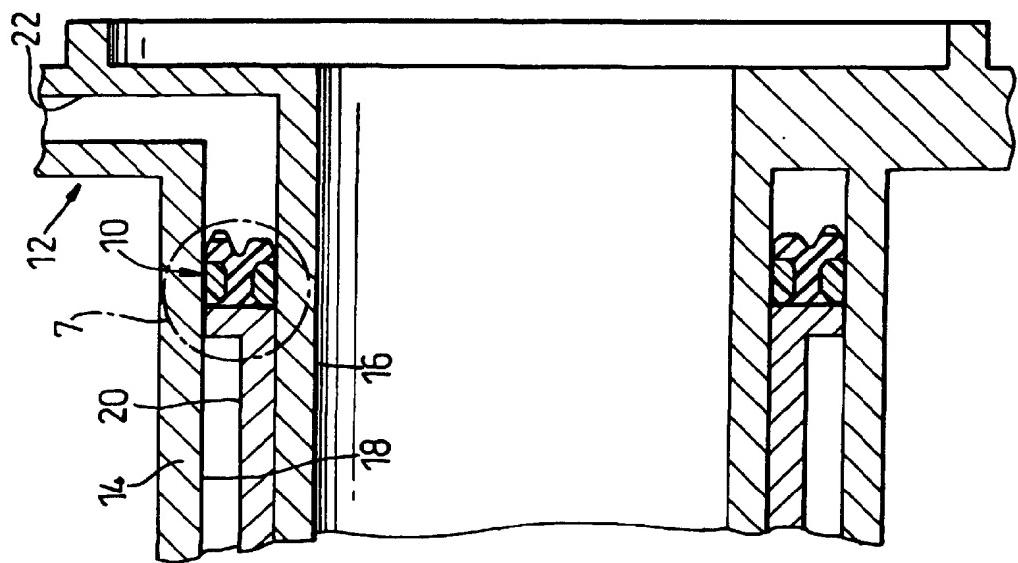
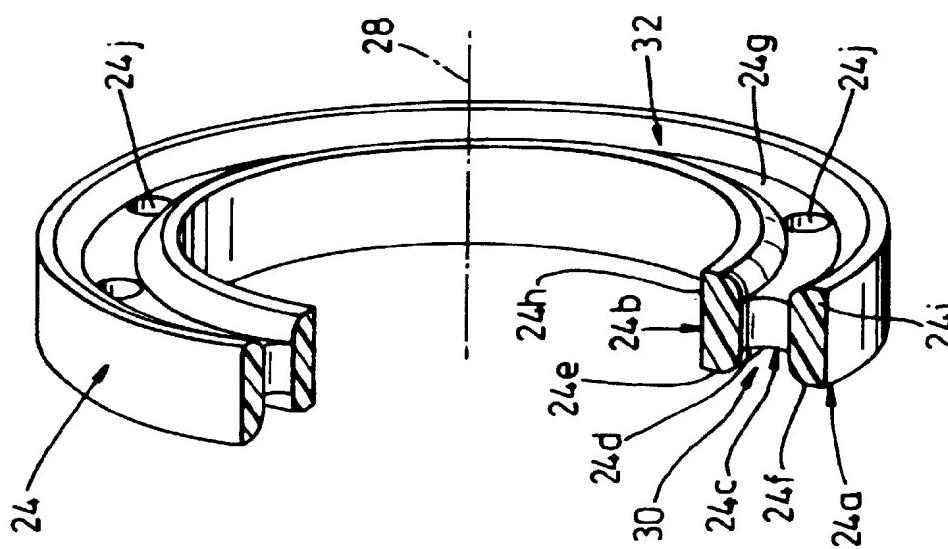
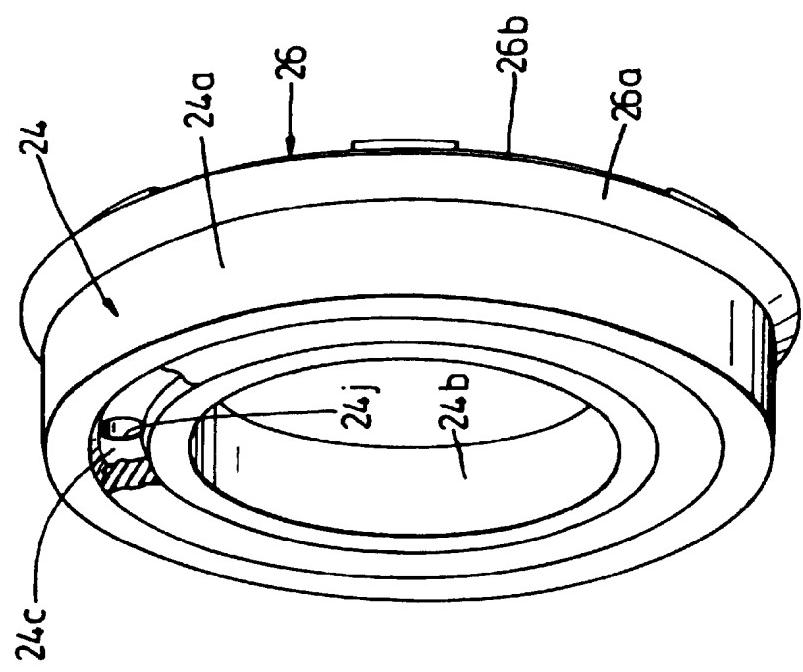


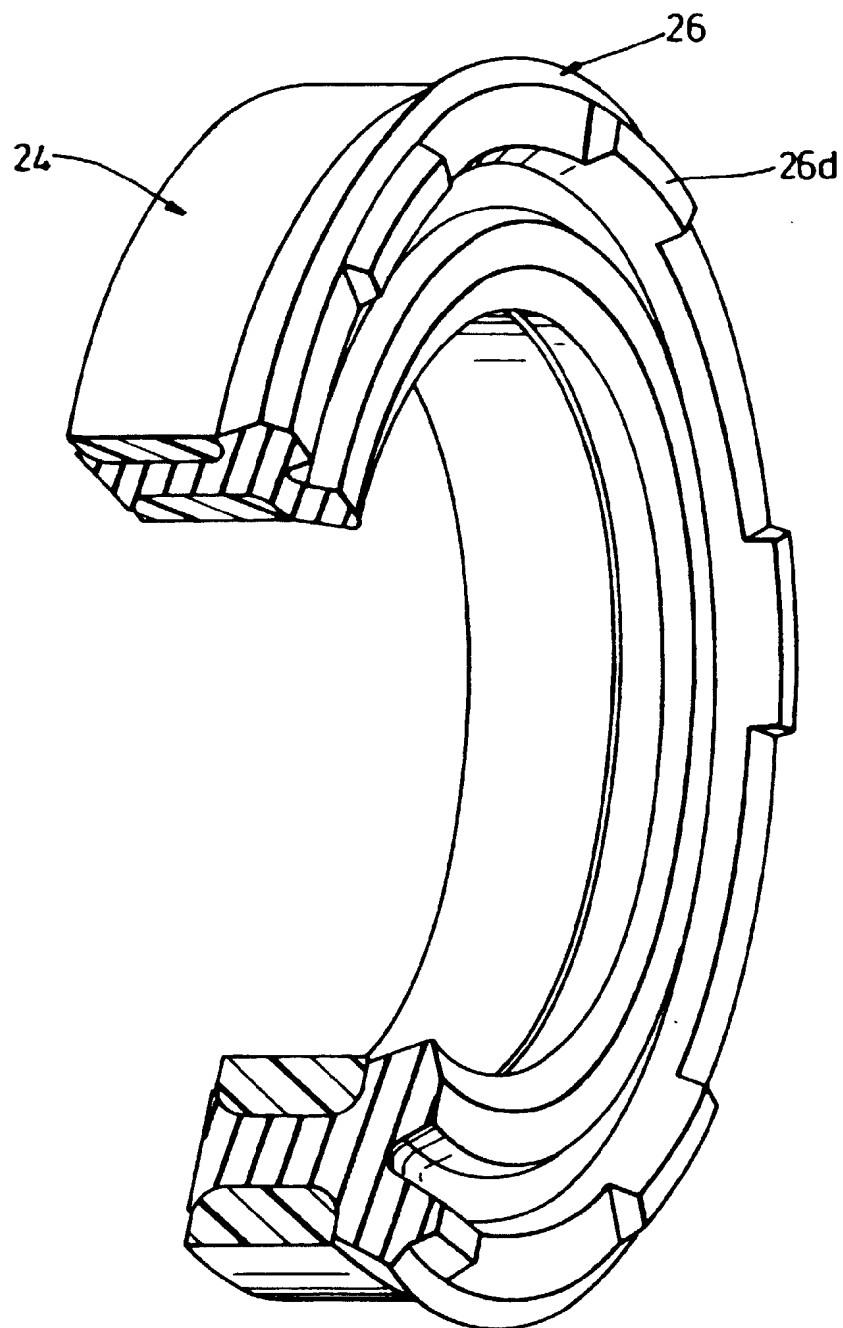
Fig. 1



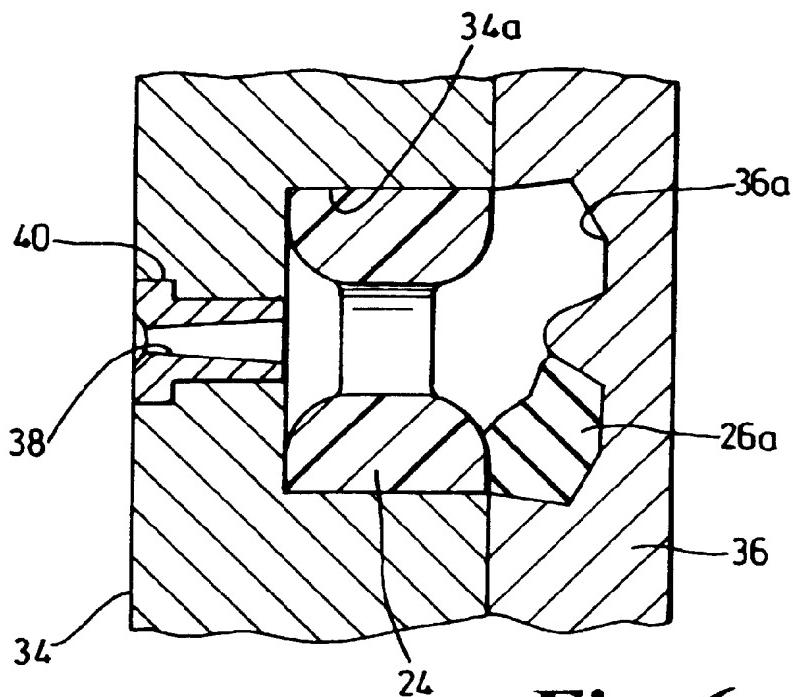
*Fig. 5*



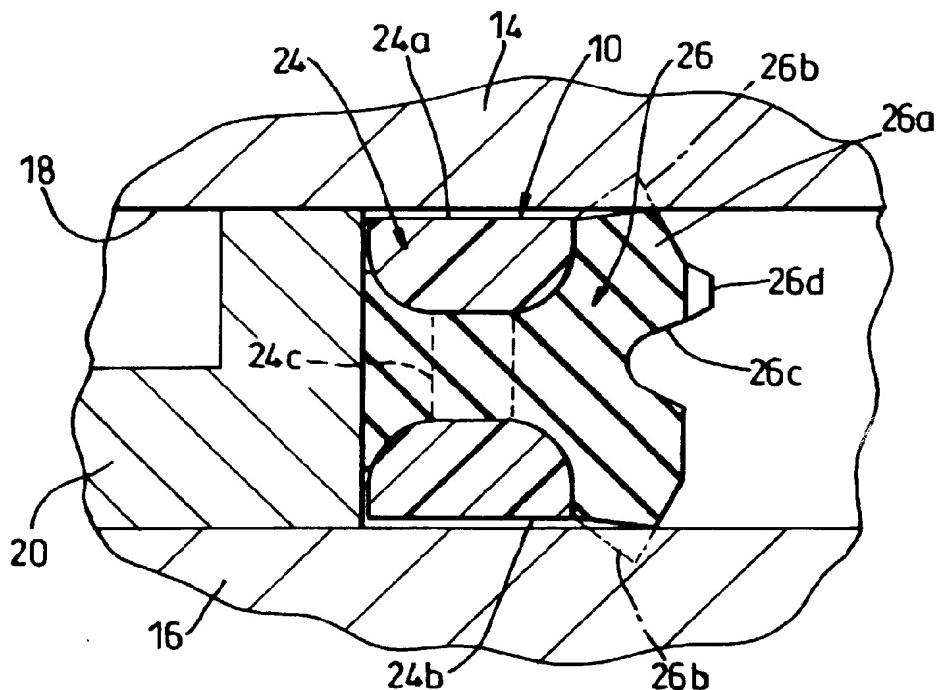
*Fig. 3*



*Fig. 4*



**Fig. 6**



**Fig. 7**